

WHAT IS CLAIMED IS:

1. A heterojunction bipolar transistor (HBT) comprising:
  - a) an emitter region of one conductivity type,
  - b) a base region of opposite conductivity type abutting the emitter region,
  - c) a collector region of the one conductivity type abutting the base region, the collector region comprising at least three layers having decreasing dopant concentrations toward the base region, the layer in the collector region abutting the base region having the lowest dopant concentration, and
  - d) a subcollector region of the one conductivity type abutting the collector region, the collector region having a non-uniform doping with lightest doping near the base region and heaviest doping near the subcollector region, the heaviest doping being less than the doping in the subcollector region.
2. The HBT as defined by claim 1 wherein the layer in the collector region abutting the base region is thicker than the other two or more layers in the collector region.
3. The HBT as defined by claim 2 wherein the layer in the collector region abutting the base region has a dopant concentration on the order of  $7 \times 10^{15} \text{ cm}^{-3}$  and the layer in the collector region abutting the subcollector region has a dopant concentration on the order of  $2 \times 10^{16} \text{ cm}^{-3}$ .
4. The HBT as defined by claim 3 wherein the subcollector has a dopant concentration on the order of  $1 \times 10^{18} \text{ cm}^{-3}$ .
5. The HBT as defined by claim 4 wherein the middle layer or layers in the collector region has or have a dopant concentration on the order of  $1 \times 10^{16} \text{ cm}^{-3}$ .
6. The HBT as defined by claim 5 wherein the layer in the collector layer abutting the base region is on the order of 2 microns in thickness and the other two or more layers in the collector region are each on the order of 0.5 microns in thickness.

7. The HBT as defined by claim 2 wherein the layer in the collector region abutting the base region is on the order of 2 microns in thickness and the other two or more layers in the collector region are each on the order of 0.5 microns in thickness.
8. A heterojunction bipolar transistor (HBT) having improved safe-operating area characterized by a collector region between a base region and a subcollector region, the collector region having at least three layers of one conductivity type and decreasing dopant concentrations toward the base region, the layer in the collector region abutting the base region having the lowest dopant concentration.
9. The HBT as defined by claim 8 wherein the layer in the collector region abutting the base region is thicker than the other two or more layers in the collector region.
10. The HBT as defined by claim 9 wherein the layer in the collector region abutting the base region has a dopant concentration on the order of  $7 \times 10^{15} \text{ cm}^{-3}$  and the layer in the collector region abutting the subcollector region has a dopant concentration on the order of  $2\text{--}4 \times 10^{16} \text{ cm}^{-3}$ .
11. The HBT as defined by claim 10 wherein the middle layer or layers in the collector region has or have a dopant concentration on the order of  $1\text{--}2 \times 10^{16} \text{ cm}^{-3}$ .
12. The HBT as defined by claim 11 wherein the subcollector has a dopant concentration on the order of  $1\text{--}5 \times 10^{18} \text{ cm}^{-3}$ .
13. The HBT as defined by claim 12 wherein the one conductivity type is N type.
14. The HBT as defined by claim 8 wherein the one conductivity type is N type.
15. A heterojunction bipolar transistor (HBT) comprising:
  - a) an emitter region of one conductivity type,
  - b) a base region of opposite conductivity type abutting the emitter region,
  - c) a collector region of the one conductivity type abutting the base region, and
  - d) a subcollector region of the one conductivity type abutting the collector region, the collector region having a continuously increasing doping concentration toward the

subcollector region with the lightest doping near the base region and the heaviest doping near the subcollector region, the heaviest doping being less than the doping in the subcollector region.